This assignment involves four tasks that aim to improve the performance of a deep learning model. The first task requires implementing the model described in a Collab Notebook and training it on a given dataset. The performance of the model is evaluated using plots of losses and metrics for both training and validation data, as well as an analysis of correctly and incorrectly labelled images. The second task involves testing the model with two additional optimizers and different learning rates to determine the best configuration. The third task focuses on the impact of varying batch sizes on training time using the Early Stopping callback. Finally, in the fourth task, the model is modified to include at least two regularization techniques, and the results are compared and contrasted with the initial model configuration.

Task 1:

In first task, the told architecture of the model is developed for cifar10 dataset for classification into ten classes ('plane', 'car', 'bird', 'cat', 'deer', 'canine', 'frog', 'horse', 'boat', 'truck') labeled 0-9. SGD (Stochastic Gradient Descent) is a popular optimization algorithm used in machine learning for minimizing the cost function during training of a neural network. SGD is used as optimizer and model is trained and validated. Figure 1 shows the Model loss and Model accuracy for train and validate sample of dataset. As shown in figure 1 loss decreased for train sample but for validation sample loss increase as epoch increases. Same is the case with accuracy , it decreased for val sample and could not cross 0.6 while accuracy of the train dataset is 0.9 as for 50 epochs.

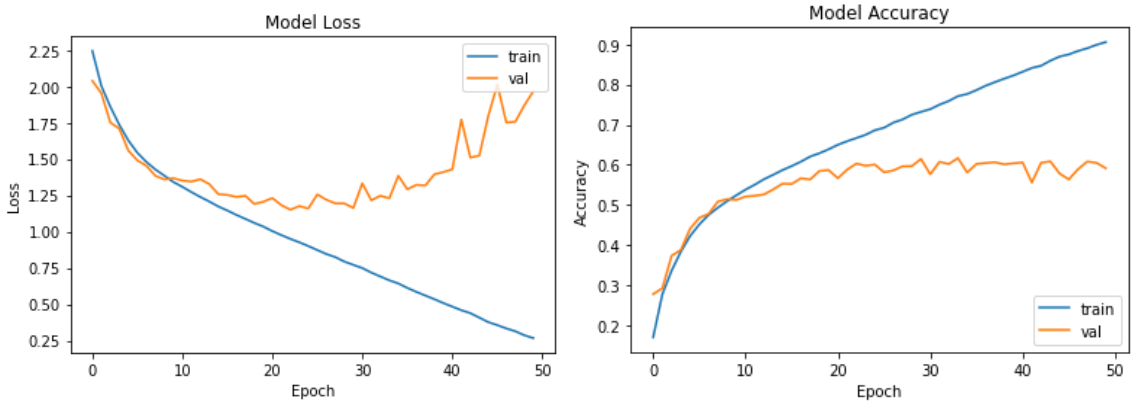

Figure 1 Loss and accuracy of the model

Task 2:

In second task, model was trained for three different optimizers i.e., SGD, Adam and RMSprop with four values of learning rates (0.001, 0.01, 0.1, 1.0). It was found that SGD with learning rate 0.01 has highest loss value for test data while RMSprop and Adam with learning rate 0.01 for train sample have lowest value for loss. If we look at accuracy highest was recorded for SGD 0.01 and 0.001 for train data and lowest accuracy was recorded for Adam and RMSprop for learning rate 1.0 with train and test data respectively. The average accuracy was recorded for Adam optimizer for learning rate 0.1 and 0.01 for test data.

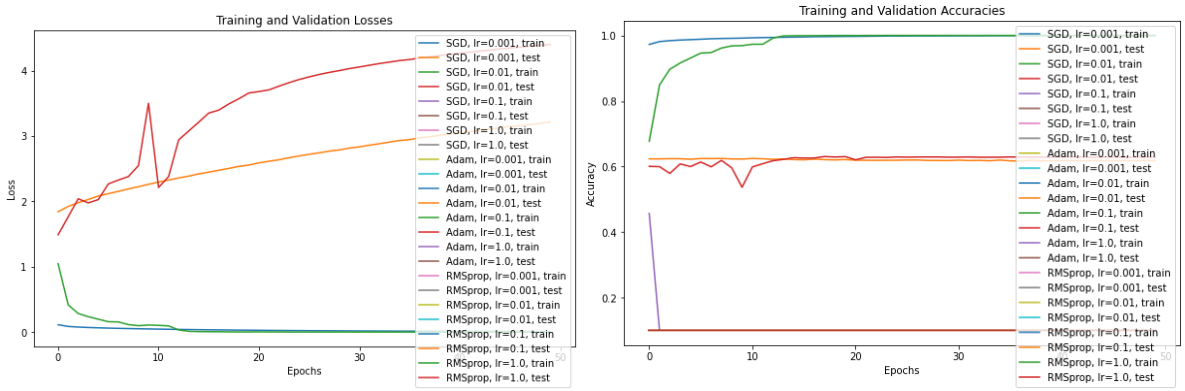

Figure 2 Loss and Accuracy for different learning rate with three different optimizers

Task 3:

Early stopping is a technique used in machine learning, particularly in training deep neural networks with Keras, to prevent overfitting and improve generalization of the model. The callback function checks whether the validation loss has stopped improving for a specified number of epochs (i.e., a patience parameter) and stops the training process early if no improvement is observed. The Table 1 shows the summary of the epochs, accuracy and loss for different batch sizes i.e., 16, 32, 64, 128 and 256. It can be seen in table that highest epoch used are 14 and lowest is 6 used for all batch size except 16 sizes.

Table 1 Summary of Batch size experiment

Batch Size	Epochs	Test Accuracy	Test Loss
16	14	0.65	1.24
32	6	0.67	2.55
64	6	0.68	3.10
128	6	0.68	3.22
256	6	0.68	3.26

Task 4:

Regularization is a technique used in machine learning to prevent overfitting, which occurs when a model is too complex and captures noise or random fluctuations in the training data, rather than the underlying patterns that generalize well to new data. In last task, regularization is applied to the task 1 model and it was noted that loss of the validation set increased compare to simple loss recorded previously.

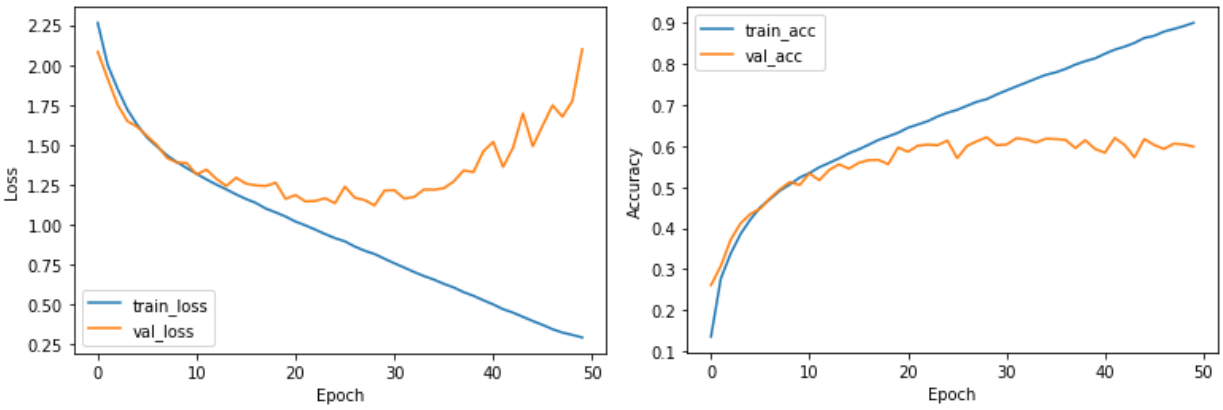

Figure 3 Loss and Accuracy of the regularized model

Figure 4 shows the 10 images with their actual and predicted values. It can be seen that 6 out of 10 value are predicted correctly and while their were very false where cat was predicted as bird.

Figure 4 Sample of Images with true and false prediction